RESEARCH DEPARTMENT

The suppression of corona–and precipitation–interference in v.h.f. television reception:

THRUMSTER EXPERIMENTS, second series.

REPORT No. E·080/2

1963/60

THE BRITISH BROADCASTING CORPORATION

ENGINEERING DIVISION

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SUMMARY

Tests have been continued at the Thrumster station to assess the degree of suppression that can be provided against 'precipitation-static' interference on v.h.f. A second series of tests was carried out between August 1961 and February 1962 to assess the degree of interference due to charged precipitation. As for the earlier series of tests, the interference levels from two aerial systems were compared both subjectively and objectively. One was protected against both corona- and precipitation-interference and (for this second series of tests) the other was protected only against corona-interference.

A criterion is suggested which determines the necessary duration of the tests in order to achieve a given accuracy of result.

The results show that charged precipitation (both rainfall and snowfall) contributes very significantly to 'precipitation-static' interference.

1. INTRODUCTION

Many of the BBC low-power Band I transmitting stations rely, for their source of programme, upon receiving the signal radiated from another transmitter. Reception is sometimes degraded during thundery weather by the occurrence of 'precipitation-static' interference; a programme of work in progress at the Thrumster station, Caithness, designed to study the phenomenon and to effect a cure, has previously been described.[1,2,3] The interference is believed to be due to the impact of charged precipitation (i.e. charged rain-drops or snow-flakes) on the aerial elements, or to the occurrence of corona discharges from the aerial elements and the support tower, or to both simultaneously.

The work was initially directed towards suppressing the interference arising from both causes, and two distinct forms of protection (viz. insulating tubes shrouding the aerial to protect against precipitation-interference, a spike and parasitic reflecting rods above the aerial to protect against corona-interference) were provided; such an aerial is described as 'fully protected'. Both forms of protection contribute appreciably to the mast loading and it was desirable to find whether both were necessary.

This report gives the results of a second series of tests performed at Thrumster to assess the occurrence of interference due to charged precipitation alone, relative to the occurrence of interference due to both causes.

2. CONDITIONS OF TEST

The television signal at Thrumster is obtained by direct reception of the Channel 4 horizontally polarized transmissions from Meldrum, using a double three-element Yagi aerial having about 9 dB gain relative to that of a half-wave dipole. The median field strength of the Meldrum signal at Thrumster is about 500 μV/m. For the first series of tests, the signal received on a fully protected aerial was compared subjectively and objectively with the signal received on a similar, but unprotected, aerial.[1,2,3]

For this second series of experiments, the previously unprotected aerial was protected against corona-interference, by the means described above, but not against precipitation-interference; in this report, this is termed the 'corona-protected' aerial. Subjective and objective comparisons were made, as for the first series of experiments, between the signals received on the two aerials. Since the results of the first series of experiments showed that full protection almost completely eliminated the interference, the residual interference occurring on the corona-protected aerial can be taken to be due to charged precipitation alone.

3. RESULTS

3.1. The Relation between Corona-Current Flow and the Occurrence of Interference

The interference occurring on the aerials during a series of measurements is governed by the degree of electrical activity that occurs in the atmosphere during the period concerned. In order to compare the results of two series of measurements performed over different periods, it is first necessary to make them correspond to similar degrees of electrical activity. If the tests could continue over very long equal periods, similar degrees of activity would probably occur. The periods, however, would then be inconveniently long, and it is desirable instead to limit each test to the shortest possible time, consistent with providing a result of sufficient accuracy.

Whilst there is no apparent correlation between the magnitude (or sign) of the corona current and the magnitude of the interference, the duration of the corona-current flow has been found to give a good guide to the duration of electrical activity; it may therefore be used to indicate when the measurements have proceeded long enough for the results to have a given accuracy.

It is well known[4] that, when assessing a result from a number of measurements the number of measurements required for the result to have a given accuracy can be determined from a knowledge of the standard deviation of the measured values. The result is said to lie (with a specified confidence) between two limits (known as 'confidence limits') which, for a given standard deviation, can be brought as close to each other as necessary by including a sufficiently large number of measurements.

This technique has been applied to these experiments, taking for each measurement the proportion of the time during each occasion of corona-current flow that a given level of interference was measured objectively.

The standard deviation of measurements is such that the duration of a given level of interference can be assessed, with 95% confidence, to within ± 15% of the true value (i.e. the value that would be obtained after infinite time) provided that the given level has occurred for a total of 500 minutes. In the general case, the accuracy increases in proportion to the square root of the period; a period of 250 minutes, for example, would provide an accuracy of about ± 21%. Since the subjective and objective results are in good agreement, it is reasonable to suppose that a similar argument applies to the subjective results.

3.2. Subjective Comparisons

Over the period of the experiments (15th August 1961 to 2nd February 1962), 266 reports were received, covering a total duration of 1707 minutes. On 120 of these occasions (covering a duration of 669 minutes), however, no interference was observed on either aerial; the reports were made only because corona current was measured in the spike above the fully protected aerial. The degree of interference observed on the remaining 146 occasions (covering the remaining 1038 minutes) is given in Table 1.

The results of Table 1 show that the aerial which was protected against corona discharges but not against charged precipitation (the 'corona-protected aerial') gave rise to considerably more interference than did the aerial protected against both causes (the 'fully protected aerial'). The difference must therefore be ascribed to charged precipitation, and the results further show that interference due to this cause alone is frequently very intense, severely degrading the value of the programme.

TABLE 1

Subjective Assessments of the Interference

SUBJECTIVE ASSESSMENT OF INTERFERENCE	FULLY PROTECTED AERIAL			CORONA-PROTECTED AERIAL		
	No. of reports	Duration minutes	% time*	No. of reports	Duration minutes	% time*
1. Imperceptible	110	731	71	1	5	½
2. Just perceptible with careful viewing	28	221	21	34	198	19
3. Perceptible but good entertainment value	8	86	8	51	293	28½
4. Slightly disturbing but fair programme value	0	0	0	17	125	12
5. Disturbing, poor programme value	0	0	0	38	343	33
6. Very disturbing, picture unusable	0	0	0	5	74	7

* i.e., percentage of the time during which interference was observed on the picture from either aerial.

3.3. Objective Comparisons

During the period of the tests, corona current in the spike above the fully protected aerial was measured for a total of 1802 minutes.* The levels of interference occurring on the two aerials are shown in Fig. 1, expressed in terms of the duration of interference which exceeded given levels per 100 minutes of corona-current flow. Similar curves, derived from the results obtained over a total corona-current flow of 1003 minutes during the first series of tests,[2] when unprotected and fully protected aerials were compared, are also drawn in Fig. 1. Subject to the limitations of accuracy discussed in Section 3.1., the four curves of Fig. 1 give a comparison of levels of interference on a fully protected aerial, an aerial protected against corona- but not precipitation-interference, and an unprotected aerial. It will be observed that the addition of the corona protection did not greatly reduce the occurrence of interference, particularly at the more intense levels (e.g. exceeding 10 μV in the ± 17½ kc/s bandwidth of the measuring receiver). This residual interference is ascribed to charged precipitation and the results show that, when this type of interference occurs, it is usually severe. This accords with the results of laboratory experiments in which charged water droplets approximately 1/8 in (3·2 mm) diameter were allowed to fall on an aerial rod. It was found that interference occurred only if the drops each carried more than 200 to 300 picocoulombs charge but that, when they did, the interference was then intense.

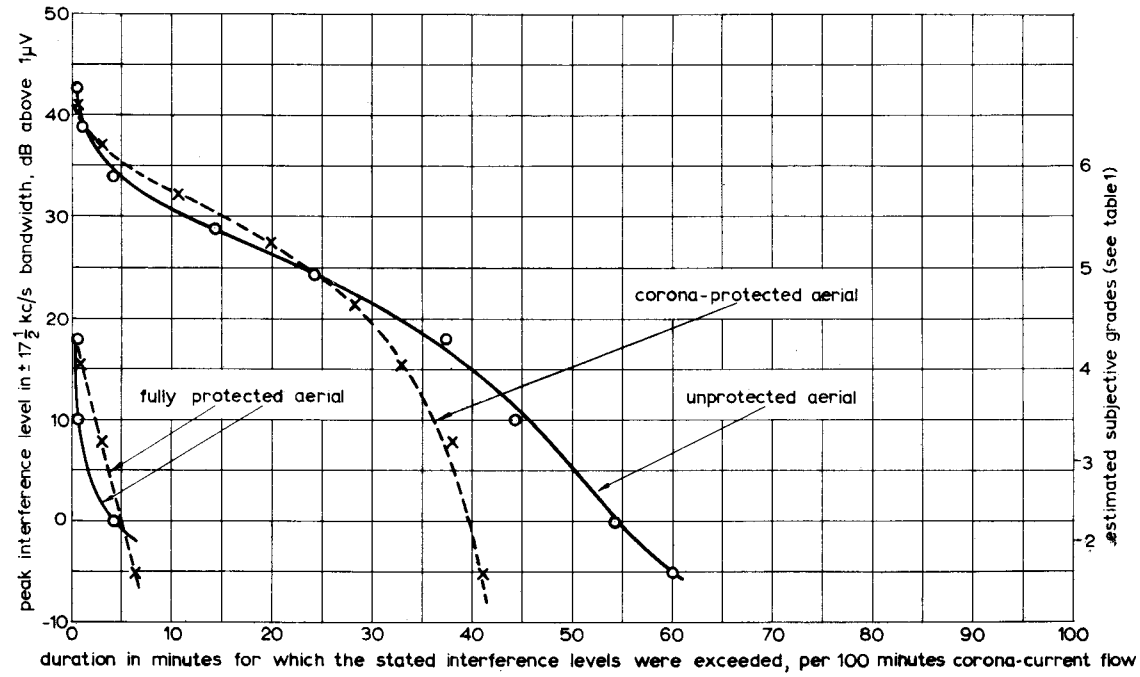

Fig. 1 —o— Average over 1003 minutes corona-current flow, November 1960 to April 1961

--x-- Average over 1802 minutes corona-current flow, August 1961 to February 1962

* This period exceeds the period (1707 minutes) of the subjective reports because objective results obtained out of programme hours are included.

3.4. The Relative Occurrence of Precipitation-Interference during Rainfall and Snowfall

Throughout the experiments, the station staff have been asked to report the weather conditions when interference was observed on the monitors. An attempt has been made to use this information in order to assess whether rainfall or snowfall is the more likely to cause precipitation-interference. This should be possible since the curves of Fig. 1 imply that charged precipitation frequently contributed to the interference during the first series of tests whilst, during the second series, it was due entirely to that cause.

The objective results of the first series of tests showed that interference on the unprotected aerial was measurable for 56% of the time that corona current flowed during rainfall, and for 73% of the time that corona current flowed during snowfall. During the second series of tests, interference was measurable on the corona-protected aerial for 43% of the time that corona current flowed during both rainfall and snowfall.

These results are obviously not conclusive with regard to relative occurrence, but they do show that both rainfall and snowfall are likely to cause interference.

4. CONCLUSIONS

Both the subjective and the objective results show that charged precipitation contributes very significantly to precipitation-static interference. If protection against only corona-interference is provided on the aerial at Thrumster, where the median field strength is about 500 μV/m, the occurrence of 'just perceptible' and 'perceptible' interference may be reduced by about 30% but the occurrence of 'disturbing' and 'very disturbing' interference is not likely to be greatly affected. This is in agreement with the results of laboratory experiments which show that precipitation-interference, when it occurs, is intense.

No firm conclusion can be drawn as to whether rainfall or snowfall is the more likely to cause precipitation-interference but the results imply that both forms of precipitation are equally potent in this respect.

The results described in this report enable the occurrence of precipitation-interference to be assessed but, since it is likely that corona-interference is itself intense when precipitation-interference occurs, the results cannot be used to assess the interference that would have occurred due to corona discharges alone. Further tests are being arranged, for which the experimental aerial will be protected only against precipitation-interference, so that, in conjunction with these results, the relative occurrence of the two forms of interference can be decided. At the present time, however, it appears that both forms of protection should be provided.

5. ACKNOWLEDGMENT

All the subjective reports were compiled by the Engineer-in-Charge and staff at Thrumster, who also assisted considerably in the maintenance of the measuring equipment. Their willing co-operation is gratefully acknowledged.

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Printed by B.B.C. Research Department, Kingswood Warren, Tadworth, Surrey